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Photostability of glycine and nitrogen basis in cometary grains : application to the transport of organic matter within the primitive Earth

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1. Introduction :

The study of photochemistry in the solar system is of prime importance to assess complex organic chemistry in any extraterrestrial environment. Among those environments, comets and grains ejected from their nuclei are of particular interest in the context of astrobiology as they could have brought organic matter on the primitive Earth, and hence contribute to the emergence of life. Furthermore, they can provide precious information on the physico-chemical parameters prevailing in the primitive solar nebula during its formation.

In this context, we are studying the extent to which organic matter within grains may survive to solar radiation and the fraction of these organic molecules destroyed when it is subjected to sunlight.

2. Methodology and results :

Our work deals with the study of photochemical degradation of three nitrogenous bases (adenine, guanine and uracil) and one amino acid (glycine) in the solid phase subjected to VUV/UV energetically radiations (λ <300 nm). The absorption cross sections of these molecules have been measured in the 115-300 nm range [1] (figure 1) . These new data are then incorporated in a model which simulates the photodestruction kinetics of a pure organic film. The comparison between this model and experimental data collected with samples irradiated in low earth orbit [3, 4] as well as in the laboratory, allow to estimate accurately the photochemical lifetimes at different heliocentric distances. These lifetimes can be compared to the grains travel time, ie submitted to irradiation, once they are ejected from comet nucleus until a hypothetical arrival on Earth, and this, from different heliocentric distances of ejection. We will also describe the extent to which organic molecules can be protected from UV radiation by the minerals composing cometary grains.

The results can lead to better understand the contribution of cometary grains in the establishment of an organic reservoir on primitive Earth. It can also be relevant to the interpretation of measurements by the Rosetta spacecraft in the environment of comet 67P.

Results show that glycine, adenine and guanine, potentially existing inside the cometary grains, would be entirely destroyed between the ejection of the grains and the arrival on earth if they exist at the surface. Below the surface, they are at the contrary very stable, thanks the effective protection of the mineral constitutive of the grain against solar radiations.

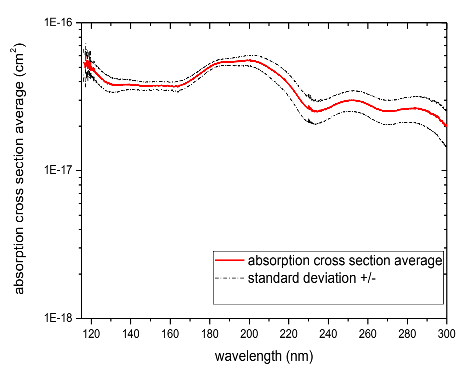

Figure 1 : Absorption cross section (cm2) of guanine solid sample (from 115 to 300 nm).

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